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Potato Spindle Tuber Control

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A "spindle-tuber" potato (left) compared with a healthy tuber (right), both of Irish Cobbler variety. Note that the diseased tuber (left) is cylindrical in shape and has a greater number of eyes, which protrude and have pronounced "brows."

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BULLETIN 487

POTATO SPINDLE TUBER CONTROL

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SUMMARY

Spindle tuber is a virus disease of the potato which affects both the plants and the tubers. The symptoms vary with the variety and the environment under which the plant is grown. The most characteristic symptom is the formation of erect and slightly dwarfed plants that produce rough, elongated, and spindle-shaped tubers.

The disease may be transmitted by aphids and certain biting insects such as grasshoppers, flea beetles, and the Colorado potato beetle. However, experiments conducted in Maine have shown that these insects sometimes are not very effective transmitting agents of the disease. The results show that spindle tuber may be readily spread by contamination of the seed stock by mechanical means during the process of storing, handling, and planting the crop.

The seed-cutting knife is an important agent of dissemination. It was learned that contamination of sprouts and eyes of seed potatoes with the sap from diseased tubers is another important source of spread.

Selection of "good typed" seed tubers and roguing "scatter planted" fields has given little control of the disease.

Spread of the disease may be reduced by drying cut seed before planting and covering.

Spindle tuber often is difficult to detect in the field, and therefore is not readily rogued from the seed plot. Planting the seed plot by the tuber-unit method will aid in detecting the disease. Roguing should be thorough and done as early in the season as possible. It is recommended that healthy tuber lines be selected in the seed plot and early harvested for further propagation and seed improvement work.

The Maine Seed Potato Board and the State Feeder Farm are making good progress in the development of superior strains of disease-free seed stocks, which may be purchased by the farmers.

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INTRODUCTION

Potato spindle tuber is a virus disease. This fact was established in Maine in 1923. At that time the disease was present in about half the potato plants grown in Aroostook County, according to surveys. The disease was also a major problem in Nebraska. Research in Maine and Nebraska contributed to an understanding of the problem. The disease was soon reduced to a very minor problem in Maine, chiefly through the expanded use of a few healthy seed stocks and by the use of tuber-unit seed plots. The chief Maine-grown varieties in that period were Green Mountain, Irish Cobbler, Spaulding Rose, and Bliss Triumph.

In recent years spindle tuber has been more or less of a nuisance in some of the newer commercial varieties such as Chippewa, Katahdin, and especially Kennebec. Varietal differences in symptoms and susceptibility have made it desirable to restudy the problem in these newer varieties. The results are given in this bulletin.

SYMPTOMS OF SPINDLE TUBER

Spindle tuber affects both the tubers and vines. The symptoms vary somewhat with the variety, the stage of maturity of the plant, and the environment under which it is growing. The symptoms are less pronounced at low temperatures and therefore the disease frequently is difficult to detect in the early part of the season. An accurate diagnosis of the disease may require considerable practice and experience on the part of the potato grower or inspector.

The vine symptoms are more marked in the Katahdin and Chippewa varieties than in the Kennebec. The diseased plants generally are more or less dwarfed, and the leaves stand out at sharp angles which gives the plant an erect upright "staring" appearance (Figure 1). The stems of the infected plants are more slender and darker green than normal. The darker green color is most apparent when several infected plants are grouped together in the row as when the field is planted by tuber units. The leaves are smaller and rather stiff and fold slightly upward on the midrib; they also may show a slight roughness and a rolling or twisting of the margins and tips. (Fig. 2.)

The most characteristic symptom of spindle tuber occurs in the tubers, and frequently one's suspicion of the presence of the disease on the basis of the foliage symptoms may be verified by examining the young potatoes. The tubers often are abnormally elongated and cylindrical or spindle shaped as is suggested by the name (Fig. 3). The infected tubers generally are rough in shape and may be pointed at either

FIG. 1. Healthy and spindle-tuber diseased plants of the Kennebec variety. Note that the diseased plant (left) is smaller and more erect than the healthy plant (right). The angles formed where the leaves and stems join have sharper angles which give the plant an erect "staring" appearance.

FIG. 2. Leaf from spindle-tuber plant (left) compared with leaf from healthy plant (right). Green Mountain variety. Note the depressed veins and the rolling and twisting of the margins and tips of the diseased leaf (left).

the stem or seed end. The infected tubers of the Katahdin and some other varieties often are pear shaped (Fig. 4).

FIG. 3. Tubers of the Kennebec (top), Chippewa (middle), and Green Mountain (bottom) varieties. In each variety the largest tuber (left) is healthy and the other two are spindle-tuber.

FIG. 4. Tubers of the Katahdin variety. The two largest tubers (left) are healthy and the other four are spindle-tuber. Note that the diseased tubers in the upper row are good-shaped and in the lower row are pear-shaped.

The eyes of infected tubers are more numerous and shallow than those of the healthy tubers and the brows sometimes protrude making them very prominent. Affected tubers often germinate slowly and the plants emerge later than from healthy tubers. The skin of diseased tubers is smoother and more tender than in healthy tubers, and they are more subject to bruising injury. Diseased tubers also may show characteristic growth cracks and the color of the skin may be changed (Fig. 5). The skin of the red colored varieties become pale pink and some white varieties, as the Irish Cobbler, may become dull or slightly brown colored.

HOW SPINDLE TUBER IS SPREAD

It has been shown that spindle tuber may be spread by aphids and by certain biting insects such as grasshoppers, flea beetles, and the Colorado potato beetle. In view of the fact that insects are known to spread spindle tuber, it is desirable that the potato fields be sprayed at weekly or 10-day intervals with DDT or other insecticide, which may be com-

FIG. 5. A healthy Katahdin tuber (left) compared with two tubers having spindle-tuber disease. Note that the middle tuber has a conspicuous growth crack and is pointed toward the "stem end." The tuber on the right has bulging eyes and is pointed toward the "bud end."

bined with a fungicide. However, experiments conducted in Maine show that the above mentioned insects sometimes are not very effective in transmitting the disease. The results show that spindle tuber may be readily spread by contamination of the seed stock by mechanical means during the process of storing, handling, and planting the crop. The disease may be spread by any agent or practice which transfers the sap from diseased tubers to the freshly-cut or bruised surfaces, or to the sprouts, of healthy seed potatoes.

Spread by Cutting Knife and Contamination of Cut Seed. The contaminated seed-cutting knife has been shown to be a common means of spreading spindle tuber. The knife is contaminated with the diseased potato sap when it cuts an infected tuber and it in turn infects the following seed pieces as they are being cut. The amount of infection that resulted from contamination with the cutting knife has varied up to 79 per cent in the experiments conducted in Maine. Most of the infection resulted in the plants grown from the first seed piece cut off after the knife had been contaminated. Some infection, however, still

TABLE 1

Percentage of Spindle Tuber Infection Resulting When Successive Seed Pieces Were Cut with Contaminated Knife—Triumph Variety

Test	Percentage of infection occurring				
	1st seed piece cut	2nd seed piece cut	3rd seed piece cut	4th seed piece cut	5th seed piece cut
1	5.0	1.5	0	0	1.3
2	79.0	12.5	8.3	0	0

occurred with the fifth successive seed piece cut off with the contaminated knife.

Likewise, the disease may be spread when the freshly-cut seed pieces from diseased tubers come in contact with freshly-cut or bruised surfaces of seed pieces from healthy seed tubers.

Spread by Picker-Planter. Experiments have shown that the picker type of planter also may be a source of spindle-tuber dissemination. Although only two per cent infection occurred in certain experiments as a result of inoculations with the contaminated picker-planter, it is a factor which should be considered.

Contamination of Sprouted Seed Potatoes. The results of experiments conducted at Aroostook Farm have shown that sprouting seed potatoes are very susceptible to spindle-tuber infection. The infection takes place when the tender sprouts and eyes are bruised and then contaminated with the sap from infected tubers. The writers are of the opinion that "sprout infection" may be one of the most important factors contributing to the spread of the disease under Maine conditions. Most seed potatoes are slightly sprouted or "pipped" at planting time and may become contaminated with the disease while being graded or handled prior to shipment or in the process of being cut and planted.

It may be well to mention here that the X virus disease and ring rot also are readily spread by contamination of the young sprouts and eyes of the seed potatoes.

CONTROL METHODS

Many potato growers have been unable to "clean up" their seed stocks which contain the spindle tuber disease. This is due to the fact that spindle tuber often is difficult to detect in the field and therefore the disease is not easily rogued from the seed plot. This is especially true when spindle tuber is disseminated by contamination of the seed stocks with the sap from infected tubers, a few of which may serve as a serious source of spread; here the appearance of vine symptoms may be delayed. The control of spindle tuber depends to a large extent on the development of disease-free seed stocks and the adoption of certain precautions to avoid recontamination.

Ineffectiveness of Selection of "Good Typed" Seed Potatoes. It is believed by many that spindle tuber can be eradicated from a seed stock by hand selection of "good typed" seed tubers. Experiments, however, have shown that little progress is made in controlling spindle tuber by tuber selection in the bin. This practice has failed because some infected tubers do not show symptoms of the disease due to lateness of infection of such tubers during their growth. In an experiment conducted at the

State Feeder Farm, 1500 large ideal-shaped tubers were selected from a seed stock known to have spindle tuber. The hand-selected tubers from this seed stock showed 2.1 per cent spindle tuber when planted, compared with 2.4 per cent in the same seed stock not selected for "tuber type." [3] Similar results have been obtained by farmers who have tried to use the tuber selection method for the control of spindle tuber.

Seed Plots and Roguing Spindle Tuber. A tuber-unit seed plot is desirable for the control of spindle tuber as well as of other virus diseases. When the seed plot is planted by the tuber-unit method, the plants from each diseased tuber are grouped together in the row and are more easily detected and removed. This is especially true of spindle tuber where the vine symptoms often are not very distinct. Thorough roguing of spindle tuber cannot be accomplished in fields that are "scatter planted" because it is impossible to detect all of the infected plants when not grouped in tuber units. All of the plants from a tuber unit should be removed even if the disease is found in only one or two of the plants in the unit.

The seed plot should be planted as early in the spring as possible. Roguing should be done as soon as the disease can be detected and care should be taken to remove all of the seed pieces and all new tubers if these have developed in the rogued units. It also is desirable that the seed plot be isolated from potato fields that have spindle tuber and other virus diseases.

Selection and Propagation of Healthy Tuber Lines. Seed plot roguing, although helpful in the control of spindle tuber, often has not completely eliminated the disease when used independently of other control measures.

Attempts were made to eradicate spindle tuber from approximately 98 farmers' seed stocks in 1948 and 1949 by the seed plot roguing method. The results showed that the prevalence of the disease was reduced by roguing in many of the seed lots, but in no case was it completely eradicated. The average percentage of spindle tuber in the seed stocks that had been rogued for two years was approximately 1.7 per cent.[4]

In contrast, the data show that the propagation of healthy tuber units selected in the seed plot combined with roguing and other seed plot methods is the best way of developing disease-free strains of seed potatoes. Experiments indicate that the spread of spindle tuber is easier to control in northeastern Maine than the spread of mild mosaic, leafroll, and some other diseases. Spindle tuber was eliminated from a number of com-

[3] Data supplied by Wesley Porter and Donald Merriam.

[4] From data supplied by E. L. Newdick.

mercial seed lots and seedling varieties by the selection of healthy tuber lines from tuber-unit seed plots followed by rigid seed plot practices.

The following procedure is recommended for the development of disease-free seed stocks. Only the best seed stock available should be used for this purpose and it should be planted by the tuber-unit method, as early in the spring as possible. Careful roguing is essential. The most vigorous healthy appearing tuber units are marked in the seed plot and are under careful observation until harvest. Do not select tuber units that are adjacent to or near diseased plants or spaces where plants have been rogued.

The selected tuber units are harvested early enough to get ahead of any insect infestation that may develop in spite of spraying or dusting. Only tuber units with undoubtedly healthy tubers should be selected. Each hill is bagged as a hill lot. The hill lots from a given tuber unit comprise a tuber line.

Next year in the seed plot, the hill lots should be planted one at a time, and the hill lots of each tuber line should be planted along the row before starting another tuber line. Weekly observations should be made during the growing season for symptoms of spindle tuber (and other virus diseases). If spindle tuber is found in a hill lot, the whole lot should be removed. Usually most of the hill lots are healthy. If a tuber line appears more vigorous than the others, it can be kept separate for increase.

The procedure described above may appear too detailed to some farmers for them to follow, and many may prefer to buy clean seed instead of developing it themselves.

The Maine Seed Potato Board and the State Feeder Farm were organized for the purpose of developing superior seed potatoes for the farmers of Maine. These organizations have made good progress in the development of superior disease-free strains of seed potatoes of the commercial and seedling varieties of potatoes. The efforts recently have been devoted to the development of Kennebec seed potatoes that are free of spindle tuber. It is recommended that any interested farmer purchase enough disease-free stock for a tuber unit seed plot and then increase it to fulfill the needs of his farm.

Planting Whole Tubers from Early Harvested Seed Plot. The writers in some cases have found it desirable to plant small whole tubers which have been "early harvested" from the tuber-unit seed plot. The small two to four ounce tubers are thought by some to be ideal for planting whole. Planting whole tubers has the advantage of eliminating the possible transmission of spindle tuber and the X virus with the cutting knife. It is recommended for the purpose of obtaining small quantities

of healthy seed stocks with which to start the seed improvement program on individual farms.

Disinfection of Seed Pieces and Cutting Knife. Experiments have shown that treating cut seed may reduce the spread of spindle tuber by the cutting knife. Treatment of cut seed, however, is not recommended at present because of injury, caused by the treating solution, which may greatly reduce the stand and vigor of the plants.

The seed cutting knife should be disinfected after each tuber is cut.[5] Disinfection of the cutting knife may be done in the field as the seed plot is planted. On Aroostook Farm it has been found very satisfactory to cut the tubers and disinfect the knives in the potato bin before the planting is done. In this case the individual seed pieces are cut two thirds or three fourths through the tuber so that they can be easily broken off when planted in the field. These partly cut tubers can be stored in boxes, barrels, or crates until planting time.

Drying Contaminated Seed Pieces Before Planting. Several experiments have shown that allowing contaminated seed pieces to become dried before being planted may greatly reduce the spread of the disease. In one experiment, seed pieces contaminated with the cutting knife produced no spindle tuber when stored in crates in a dry cellar for eight days before planting, compared with eight per cent infection when similar seed pieces were planted immediately after being contaminated. Contaminated seed pieces stored in paper bags for one hour before being planted, contracted less disease than those planted immediately after contamination. Also the amount of infection was reduced from 24 per cent to none by a two-hour delay of covering with soil in the field. The amount of infection was reduced from 50 per cent to 3 and 0 per cent respectively by two- and four-hour postponements of covering.

These results suggest that a practical method of reducing spindle-tuber infection by the knife would be to leave the seed pieces uncovered in the furrow for a couple of hours. However, care should be taken to place the seed pieces so that the cut surface is down. Otherwise exposure to sunlight and air may result in too much drying so that there will be weak hills and a poor stand.

Avoiding Excessive Handling of Sprouted Seed Potatoes. Sprouted

[5] The cutting knife may be disinfected by being flamed with an alcohol lamp or torch or by being dipped for a short period in an acidified solution of Corrosive Sublimate made by dissolving ½ ounce of corrosive sublimate in 1 cup of white distilled vinegar and then diluted with one gallon of water. *Warning:* Corrosive Sublimate is a deadly poison. A copper sulphate solution made by dissolving 5 ounces of copper sulphate in 1 gallon of water also has been found to be a cheap effective solution for disinfecting the cutting knife.

seed potatoes are very susceptible to both spindle tuber and X virus infection. The seed potatoes become infected with these diseases when the young and tender sprouts and the eyes are bruised and then contaminated with the sap from diseased tubers in the seed stock. Most seed potatoes are slightly sprouted or "pipped" at planting time and the disease is spread while the seed stock is being handled in the storage bin or during the process of cutting and planting the crop.

In experiments conducted in Maine, contamination of the sprouts of healthy seed potatoes resulted in approximately 50 per cent spindle tuber infection and nearly 100 per cent X virus infection. Growers therefore are advised to grade and handle their seed stocks earlier in the season before the tubers have begun to sprout. They also should avoid excessive handling and shovelling of the seed stock, especially after sprouting has begun.

AVAILABLE BULLETINS ON POTATOES

If you desire any of the following research bulletins, a copy may be obtained without charge by sending your request to the Maine Agricultural Experiment Station at Orono.

Potato Diseases and Insect Control

370. Isolated Tuber-unit Seed Plots for the Control of Potato Virus Disease and Blackleg in Northern Maine. 1934. 32 pages.
407. Results of Testing Some Laboratory Methods for Possible Use in the Detection of Virus Diseases in Potato Tubers. 1941. 21 pages.
416. Potato Refuse Piles as a Factor in the Dissemination of Late Blight. 1943. 17 pages.
421. Rate of Spread and Effect on Yield of Potato Virus Diseases. 1943. 28 pages.
446. Potato Yellowtop and Unmottled Curly-Dwarf in Maine. 1946. 8 pages.
447. The Effect of Fertilizer Practice Including the Use of Minor Elements on Stem-end Browning, Net Necrosis, and Spread of Leafroll Virus in the Green Mountain Variety of Potato. 1947. 45 pages.
469. Maine Potato Diseases, Insects, and Injuries. 1949. 44 pages.
470. Progress on Some Important Insect and Disease Problems of Irish Potato Production in Maine. 1949. 50 pages.
471. Control of Potato Late Blight Tuber Rot. 1949. 16 pages.
480. Control of Aphids on Potatoes with DDT When Used with Fungicides. 1950. 41 pages.
482. Factors Affecting Potato Blackleg and Seed-Piece Decay. 1950. 31 pages.

Fertilization and Use of Potato Seed

414. Potato Fertilizer-Rotation Studies on Aroostook Farm 1927-1941. 1943. 82 pages.
439. Size of Whole and Cut Seed and Spacing in Relation to Potato Yields. 1945. 33 pages.
454. Fertility Status of Potato Soils of Aroostook County, Maine, and Relation to Fertilizer and Rotation Practices. 1947. 43 pages.
463. Effects of Certain Soil Conditions and Treatments Upon Potato Yields and the Development and Control of Potato Scab. 1948. 31 pages.
474. Green Manure Crops and Rotations for Maine Potato Soils. 1949. 40 pages.
481. Effect of Rate and Source of Potash on Yield and Starch Content of Potatoes. 1950. 24 pages.
490. Rate, Placement, and Source of Nitrogen for Potatoes in Maine. (in press 1951.)

Production Costs and Marketing Studies

392. Costs and Returns in Producing Potatoes in Maine. 1938. 34 pages.
465. Consumers' Acceptance of Sized Potatoes. 1948. 15 pages.
466. Quality of Potatoes in Retail Stores in Boston, Massachusetts, and Maine Markets, 1948. 1949. 50 pages.
472. Practices, Costs, and Tuber Bruising in Digging Potatoes in Aroostook County, Maine. 1949. 53 pages.

476. Grade Quality of Maine Potatoes Inspected at Shipping Points for Three Years, 1945-47. 1949. 31 pages.
484. Development of Defects in Potatoes Between Shipping Points in Aroostook County, Maine, and Wholesale and Retail Markets in Boston, Mass. 1950. 35 pages.
485. Effect of Potato Acreage Adjustments on Farm Practices in Aroostook County, Maine, 1948 and 1949. 1950. 67 pages.
486. The Development of External Defects in Maine Potatoes at Retail Stores in Boston, Massachusetts, February and March, 1950. 1950. 24 pages.